West Science Information System and Technology
Vol. 04, No. 01, April 2026, pp. 46~55

Cloud Computing Research (2010–2026): A Scopus-Based Bibliometric Analysis of Intellectual Structure and Topic Shifts

Loso Judijanto[1], Rizki Dewantara[2]
[1] IPOSS Jakarta, Indonesia
[2] UIN Siber Syekh Nurjati Cirebon

Article Info

Article history:

Received Apr, 2026
Revised Apr, 2026
Accepted Apr, 2026

Keywords:

Cloud Computing
Topic Evolution
Scopus
Bibliometric Analysis
VOSviewer

ABSTRACT

The research aims at mapping the evolution of cloud computing studies from 2010 to 2026 through the analysis of academic literature using bibliometrics. This approach will provide information on the structure of the knowledge, major contributions, and the thematic trends within the area. In the present work, the bibliometric analysis is based on Scopus indexation. The research uses several types of analysis: co-authorship, citation, and keyword co-occurrence analyses. VOSviewer was chosen as the main bibliographic software for data mining. The analysis shows that the field is dominated by major researchers representing countries including the USA, China, and India, which indicates a partially fragmented cooperation among experts in the domain. Bibliometric analysis through citation shows that research papers in cloud computing architecture, Internet of things, and edge computing play a crucial role, as they set the basis of the topic and show the trend toward decentralization and integration in computing. In addition, the multidimensionality of research in cloud computing was analyzed through keywords, which revealed not only technical issues but also security, applications, green computing, and energy efficiency. This study contributes to the literature by providing a systematic overview of the development and current landscape of cloud computing research, offering valuable insights for researchers and practitioners in identifying future research directions and opportunities for interdisciplinary collaboration.

Corresponding Author:

Name: Loso Judijanto
Institution: IPOSS Jakarta, Indonesia
Email: losojudijantobumn@gmail.com

1. INTRODUCTION

Cloud computing has evolved into a revolutionary approach to information technology, transforming the way computing services are provided, consumed, and operated [1]. Rather than depending on local infrastructures, cloud computing enables companies to use remote computing facilities and capabilities via the Internet, which is more scalable and flexible. This change has been triggered by the rise in demand for computing power, digital transformation efforts, and interconnections between devices [1]. Cloud computing has thus become an integral part of contemporary digital environments, with its applications ranging from healthcare, finance, education, to manufacturing [2], [3].

From the advent of cloud computing in the early years of the twenty-first century until today, there have been remarkable developments in this area of study, especially from 2010 onwards because of improvements in the field of virtualization, distribution systems, and fast connections that encouraged the application of cloud computing in numerous situations [4], [5]. There is no denying the fact that scientific outputs in this field have increased remarkably due to rising interest among researchers as well as companies in applying this technology in practical life [6].

The conceptual framework of cloud computing research is very complex, as it touches upon numerous aspects like service models, security issues, resource allocation, among others. The early classification of research areas considered the stages through which cloud computing evolved, namely, incubation, exploration, and rapid growth, and defined different aspects investigated during these stages [6], [7]. However, there has been an increasing trend toward such research areas as distributed computing systems, quality of service, and mobile cloud computing.

However, the convergence of cloud computing with other contemporary technology trends, such as artificial intelligence, big data analytics, and Internet of Things, over the past few years has brought about even more variety in terms of research focus areas. The combination of these different fields is associated with the emergence of a number of new challenges, including those related to scalability, interoperability, and data management. Furthermore, matters of security and privacy along with ethics of using cloud solutions continue to be relevant issues for academic discussion.

With the enormous number of research papers published and more coming out at a faster pace, there is a possibility that conventional narrative reviews may not be able to present a holistic picture of the research topic being studied. Bibliometrics provides a scientific and quantitative methodology that can map the existing body of knowledge, establish influential sources, and reveal some underlying patterns in the process of research development. With the aid of bibliometrics, the intellectual structure and evolution of themes in a field can be investigated.

Even though there have been many advancements in the field of cloud computing research, there is a notable deficiency of a thorough bibliometric analysis that looks into the intellectual structure and evolution of topics related to cloud computing over a long period of time. These bibliometric studies usually concentrate on a certain period or even only on particular sub-domains. In addition to this, many researchers conduct studies that explore one or two analytical dimensions of cloud computing but overlook others in order to simplify their work and findings. As such, it becomes difficult to trace the changes made to research themes and progress made over time owing to the fast development of other technologies. Therefore, a holistic bibliometric study based on a vast database like Scopus is necessary.

The main purpose of the current research is to perform a bibliometric analysis of the scientific publications on cloud computing in the period from 2010 to 2026 using the data from Scopus database. It is aimed at mapping the intellectual structure and topic shifts in the development of the research field under analysis. The research will pay particular attention to the examination of publications dynamics, leading authors and cooperation network, as well as the identification of the most significant and emergent research topics.

2. METHODS

In the current investigation, the use of a bibliometric approach was chosen as a methodological tool to conduct a quantitative analysis of research on cloud computing from 2010 until 2026. It is generally agreed that bibliometric research serves as an efficient tool for analyzing vast amounts of literature using statistical and mathematical methods [8], [9]. The data used in this paper was obtained from the Scopus database, which is

characterized by the inclusion of a wide variety of sources, such as peer-reviewed journals, academic papers, and conference proceedings. A specific search algorithm was designed based on keywords, such as "cloud computing" and "distributed cloud computing." Publications were included in the data set only during the required period and in English.

After the data were gathered, the collected information was exported in appropriate formats for additional analysis. The data were preprocessed to ensure consistency in the formatting of author names, affiliation details, and keywords. The use of bibliometric metrics such as the number of publications, citations, and h-index was done to assess research productivity and impact. Network analysis methods were also used to analyze the relationships between authors, institutions, and countries. Visualization software VOSviewer was used to produce visualizations of co-authorship networks, co-citation networks, and keyword co-occurrence networks.

In order to determine the intellectual structure and theme development of cloud computing studies, co-citation and co-word analyses were employed for this paper. In particular, co-citation analysis was carried out to uncover seminal articles and influential clusters of research that have had an impact on the development of the field throughout the years, whereas co-word analysis was performed to find significant themes and emerging research areas through the utilization of keywords and their relations. Additionally, temporal analysis was performed through the division of the analyzed period into sub-periods to observe the development and transition of research areas over time.

3. RESULTS AND DISCUSSION

3.1 Co-Authorship Analysis

The purpose of conducting co-authorship analysis is to study the co-operation patterns existing in the sphere of cloud computing research studies, as well as to determine the major contributors to the evolution of cloud computing. The analysis will help understand the level of scientific cooperation and how the scientific network develops. As cloud computing is a multidisciplinary and fast-developing area, scientific cooperation becomes very important in this case, which is why conducting co-authorship analysis is particularly useful for revealing the most productive research groups, influential researchers, and the level of connections between researchers in general during 2010-2026.

This visualization of the co-authorship network of the cloud computing research field from the years 2010 to 2026 was created through VOSviewer software. The figure shows how the researchers in this area of research connect with one another based on their collaborative effort, with the researchers forming clusters based on their affiliation. Here, each circle represents a researcher in the area of research, while the lines connecting them indicate how they collaborate with one another, with the circle size indicating how much the particular author has contributed to the field.

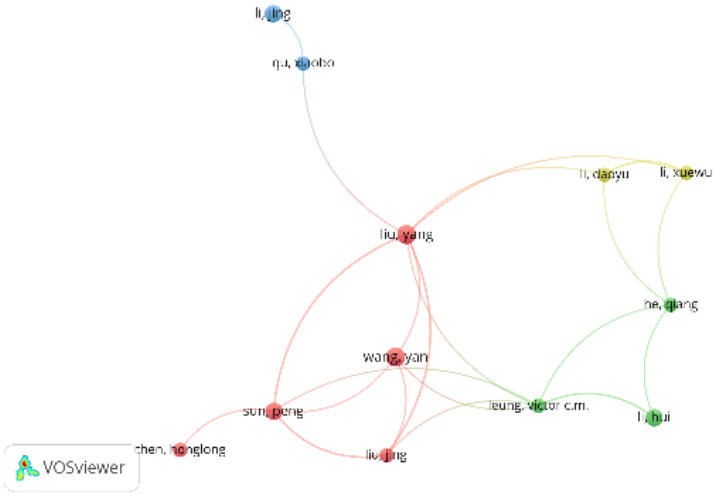

Figure 1. Author-Level Visualization
Source: Data Analysis

It is clearly evident from the visualization that there are many individual clusters formed, with each cluster depicting a cluster of authors who work together often. It is important to note that the clusters vary in colors, implying that there are many research groups in the field of cloud computing research. There are certain clusters which are denser than others, meaning that the authors within these clusters are highly collaborative with their peers, whereas the less dense clusters depict new research groups that have just started working together.

Also, from the network structure, it can be observed that collaboration in cloud computing research is fairly well connected yet still somewhat fragmented. There are a few researchers who occupy dominant positions in their own clusters, and there does not seem to be much inter-cluster collaboration taking place, which suggests that research activities may be confined within certain themes or institutions. This observation captures the nature of cloud computing research as being multidisciplinary but specialized at the same time.

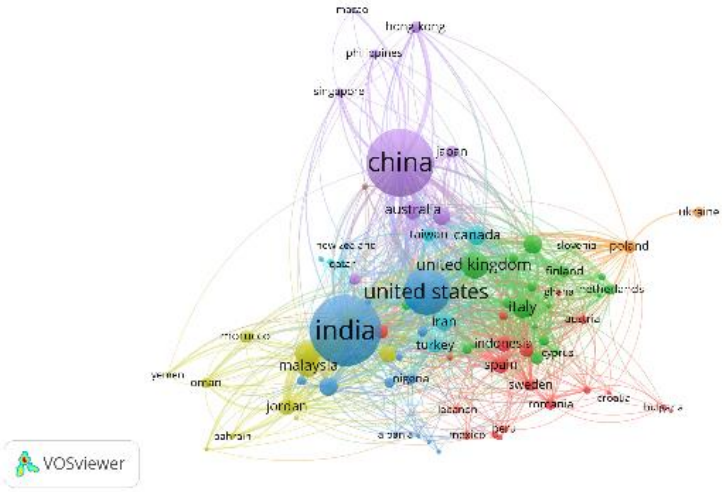

Figure 2. Country-Level Visualization
Source: Data Analysis

From the country-level visualization illustrated in Figure 2, it is evident that there is an extensively interconnected network for global collaboration on cloud computing research, which features various countries that have been identified as leading players. The United States, China, and India are some of the leading countries that stand out from the rest and are considered as the most prominent nodes in this network due to their contribution in terms of high research outputs. In particular, the United States is regarded as a hub in this network due to its high connections with not only developed countries but also other developing countries. The same case applies to China, which has also exhibited a high degree of connectivity with respect to the Asia and Europe regions. The United Kingdom, Germany, Italy, and France have formed highly interconnected networks in the region, thus showing intense regional collaborations within the region.

3.2 Citation Analysis

The technique of citation analysis is utilized for determining the intellectual basis as well as influential contributions made to the field of cloud computing research. The reason why this methodology is used is because the use of citation analysis helps researchers determine how influential certain publications, authors, and sources have been in shaping the growth and evolution of the field of cloud computing. Citations not only indicate the importance of academic literature, but also show the pattern of knowledge that is present in the research domain of cloud computing.

Table 1. The Most Impactful Literatures

Citations	Authors and year	Title
10091	[10]	Internet of Things (IoT): A vision, architectural elements, and future directions
7317	[11]	Internet of Things: A Survey on Enabling Technologies, Protocols, and Applications
7189	[12]	Edge Computing: Vision and Challenges
4968	[13]	A Survey on Mobile Edge Computing: The Communication Perspective
4459	[14]	CloudSim: A toolkit for modeling and simulation of cloud computing environments and evaluation of resource provisioning algorithms
2986	[15]	Mobile Edge Computing: A Survey on Architecture and Computation Offloading
2785	[16]	The CCPN data model for NMR spectroscopy: Development of a software pipeline
2751	[17]	Cloud computing: State-of-the-art and research challenges
2495	[18]	Intelligent Manufacturing in the Context of Industry 4.0: A Review
2466	[19]	Big Data in Smart Farming – A review

Source: Scopus, 2026

Table 1 shows the top influential literatures in the cloud computing domain based on their citation numbers in the Scopus database. From Table 1, it is apparent that the body of knowledge associated with the research in cloud computing is highly connected to other neighboring technological areas, specifically IoT, edge computing, and big data. The presence of highly cited literature, such as [10] and [11], confirms the importance of IoT as a parallel technological area that complements cloud computing to allow for the expansion of the latter's capabilities in inter-networked settings. Likewise, the dominance of the research on edge computing [12], [13], [15] shows an increasing trend towards more distributed and low-latency-oriented architecture models. The works of [14], [17] represent some of the first efforts to develop cloud

computing modeling tools and challenges in the field. Other works include studies on Industry 4.0 and smart farming.

3.3 Keyword Co-Occurrence Analysis

The keyword co-occurrence technique is applied to reveal the underlying concepts and themes in cloud computing studies. It can be done by studying the correlation between certain keywords that co-occur in academic articles. The use of this approach will allow researchers to identify prominent themes and hot topics of investigation within the discipline. Due to the evolving nature of cloud computing, which connects with other concepts such as artificial intelligence, big data, and edge computing, conducting a keyword network analysis will enable scholars to gain insight into the trends and changes in research interest in cloud computing studies over the period from 2010 to 2026.

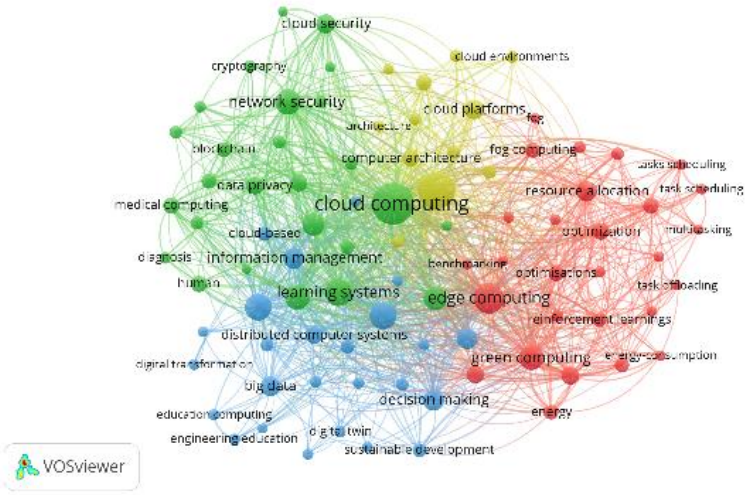

Figure 4. Network Visualization
Source: Data Analysis

The relationships between some of the common keywords in cloud computing research are shown in Figure 4 to form a structure for this area of study. There are several clusters in the network, each one standing for a topic in this field. In the middle of the diagram, there is the term "cloud computing," which stands out as the central and most-connected keyword in this area. This means that this term serves as the integrating force of cloud computing research.

Another significant cluster, highlighted in red, seems to be centered around technical and infrastructure-oriented issues, ranging from resource allocation to load balancing, among others. Such a cluster reflects the core engineering problems in cloud computing, concentrating on efficiency and performance. The tight connectivity of this group of issues indicates their close relationship, which makes them fundamental for cloud computing systems' development and optimization.

Another important cluster, shown in green, is focused on security and privacy issues related to cloud computing. Terms like "network security," "encryption," "data privacy," and "access control" play an important role within this cluster. This suggests that it is crucial to ensure that the cloud environment is secure. High connectivity among keywords within this cluster suggests that data protection is increasingly becoming a priority in the cloud computing world.

The blue color group seems to be linked with the implementation of cloud computing in the fields of learning and decision making, which include topics like e-

learning, distributed systems, and information management. In this case, it is possible to say that cloud computing can be considered as a technological infrastructure as well as an applied platform for different areas of activities. The appearance of educational-related keywords indicates the importance of using cloud technologies. Moreover, the yellow cluster identifies new trends and interdisciplinary fields, including cloud infrastructure, big data, and systems integration. This particular cluster connects the base infrastructure to applications, signifying the development of cloud computing into more advanced and data-oriented environments.

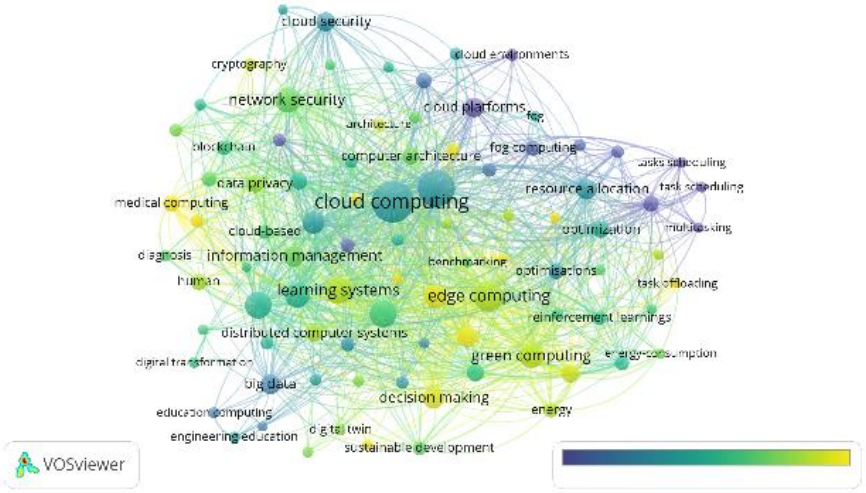

Figure 5. Overlay Visualization
Source: Data Analysis

The timeline for the development of themes of research in cloud computing is depicted in Figure 5 below. As seen in Figure 5, color denotes the average year of publication for each keyword, varying from old studies (often depicted in shades of blue) to newer studies (denoted using green to yellow shades). As can be observed in Figure 5 below, the keyword "cloud computing" is at the center, signifying that it remains relevant through the years.

The early trends in cloud computing research, denoted in darker shades, have been mainly related to the fundamentals of technology. The fundamentals of technology include aspects like distributed computer systems, computer architecture, and cloud infrastructure basics. The above-mentioned concepts form the foundation of cloud computing research at its nascent stages, where the focus was on constructing scalable systems and virtualizing them within a distributed environment.

On the other hand, more contemporary keyword phrases, which have been marked by light green to yellow colors, signify a trend towards new and applicative issues including edge computing, green computing, energy efficiency, decision making, and resource optimization. The emergence of these concepts reveals an increasing focus on issues related to sustainability, real-time operations, and intelligent systems. This shows that there has been progression in cloud computing studies from infrastructure-related matters to those that are multi-disciplinary and involve complex issues.

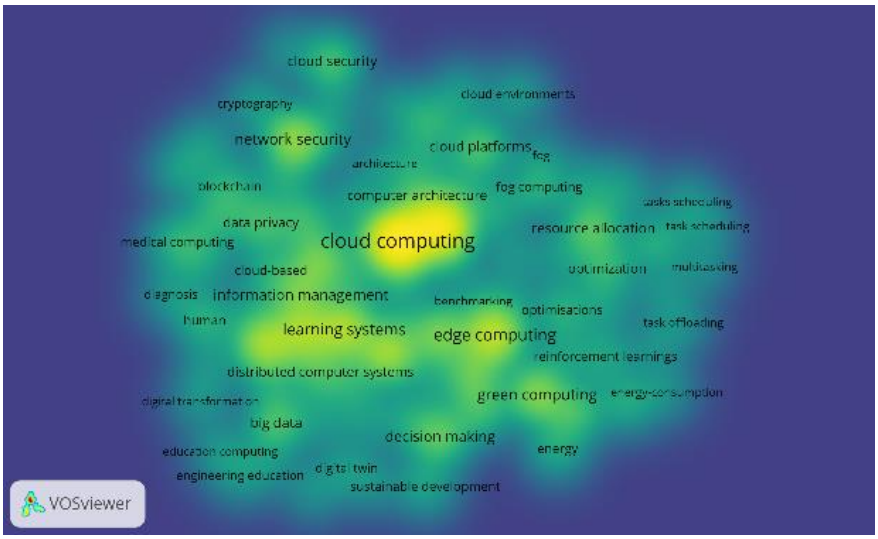

Figure 6. Density Visualization

Source: Data Analysis

Figure 6 reveals how clustered and intense the topics of research are in the cloud computing field through using bright and warm colors to depict frequently used keywords. From Figure 6, it can be seen that the term "cloud computing" is the most dominant and clustered topic, hence the most important core topic that links all other research topics together. Some of the high density clusters surrounding the core keyword include those of learning systems, computer architecture, and edge computing, implying that these topics have the highest priority among scholars.

On the other hand, keywords placed in areas that are less densely packed (i.e., dark areas) signify specialization or new research areas that are yet under development in the research domain. Some of the examples are green computing, energy usage, blockchain, and fog computing, whose occurrence is lower compared to others because they are yet to mature fully and become part of the core themes in cloud computing research. It is clear from this representation that research on cloud computing has reached an important level, both in terms of established topics and new interdisciplinary research fields.

Discussion

Results obtained from the bibliometric study show that cloud computing research has become a strongly connected, multidisciplinary discipline, with a high level of cooperation practices and a variety of intellectual structure. Results from co-authorship studies indicate that research is highly clustered within certain countries such as the US, China, and India, acting as central players in international collaboration networks. Such concentration in terms of research activities can be attributed not only to the large size of their research capability but also to strategic developments towards technology and infrastructure advancement. Despite high connectedness in general, the existence of certain clusters implies that some level of fragmentation is observed in collaboration, where cooperation occurs either regionally or thematically.

From the citation analysis, it is evident that there is a significant knowledge base forming the backbone of cloud computing research. This is evident in the manner in which the field is highly impacted by other neighboring fields such as the Internet of Things (IoT), edge computing, and big data analytics. The highly cited articles in cloud computing research, especially those that consider aspects such as IoT architecture and edge computing paradigm, are evidence of the fact that cloud computing research has moved away from cloud computing architecture to a much distributed architecture. Additionally, early research in

cloud computing architecture and modeling tools is an indication of maturity in the field.

The analysis of key word co-occurrences serves as an additional illustration of the multi-dimensional character of studies in cloud computing by outlining a number of important clusters of themes such as the optimization of cloud infrastructure, security issues and privacy concerns, application systems, and cross-disciplinary issues. The domination of technology-oriented topics in terms of resource management, task scheduling, and optimization suggests that performance still continues to be a major issue for researchers. On the other hand, the dominance of security terms shows that issues of trust and data protection are also becoming increasingly important for the discipline.

In this respect, the visual presentation shows a great deal about the evolution of research in terms of time. Initially, research was focused on distributed system architectures and cloud computing infrastructures. In contrast, currently, researchers pay attention to such issues as edge computing, green computing, energy efficiency, and intelligent decision support systems. Such a change in the topic is connected to the fact that today, there are several trends related to artificial intelligence, sustainability in computing processes, and the necessity to process data in real time. The appearance of these trends proves that cloud computing serves as the basis for future digital ecosystems.

The density plot illustrates the simultaneous presence of already well-established fields as well as new subjects in the realm of cloud computing. Although key fields such as cloud computing, learning, and architecture continue to dominate the field, new subjects like blockchain technology in cloud computing, energy-efficient computing, and fog computing are also starting to receive attention. These facts indicate that cloud computing is experiencing a period where both established and new directions can thrive.

4. CONCLUSION

The present study offers an extensive bibliometric assessment of cloud computing literature from 2010 until 2026, showing that this subject matter has transformed from its initial studies focused on infrastructure into a highly developed, multi-faceted field of research. Through the current analysis, it becomes evident that the intellectual structure of cloud computing is defined by the contributions made by pioneering countries and researchers. The knowledge structure of cloud computing shows high levels of interconnections with other fields such as the Internet of Things, edge computing, and big data. Thematic analysis additionally shows the existence of an obvious transition towards the study of more advanced themes such as sustainability, intelligent systems, and distributed computing.

REFERENCES

[1] S. Sawhney, K. Kacker, S. Jain, S. N. Singh, and R. Garg, "Real-time smart attendance system using face recognition techniques," in *2019 9th international conference on cloud computing, data science & engineering (Confluence)*, IEEE, 2019, pp. 522–525.

[2] O. Jayeola, S. Sidek, A. Abd Rahman, A. S. B. Mahomed, and J. Hu, "Cloud computing adoption in small and medium enterprises (SMEs): A systematic literature review and directions for future research," *Int. J. Bus. Soc.*, vol. 23, no. 1, pp. 226–243, 2022.

[3] S. El Kafhali, I. El Mir, and M. Hanini, "Security threats, defense mechanisms, challenges, and future directions in cloud computing," *Arch. Comput. Methods Eng.*, vol. 29, no. 1, pp. 223–246, 2022.

[4] S. Kanungo, "REVOLUTIONIZING DATA PROCESSING: ADVANCED CLOUD COMPUTING AND AI SYNERGY FOR IOT INNOVATION," *Int. Res. J. Mod. Eng. Technol. Sci.*, vol. 2, pp. 1032–1040, 2020.

[5] U. O. Matthew, J. S. Kazaure, and N. U. Okafor, "Contemporary development in E-Learning education, cloud computing technology & internet of things.," *EAI Endorsed Trans. Cloud Syst.*, vol. 7, no. 20, p. e3, 2021.

[6] J. Qin and Q. Qin, "Cloud platform for enterprise financial budget management based on artificial

intelligence," *Wirel. Commun. Mob. Comput.*, vol. 2021, no. 1, p. 8038433, 2021.

[7] M. S. Hasan, F. A. de Oliveira, T. Ledoux, and J.-L. Pazat, "Enabling green energy awareness in interactive cloud application," in *2016 IEEE International Conference on Cloud Computing Technology and Science (CloudCom)*, IEEE, 2016, pp. 414–422.

[8] N. Donthu, S. Kumar, D. Mukherjee, N. Pandey, and W. M. Lim, "How to conduct a bibliometric analysis: An overview and guidelines," *J. Bus. Res.*, vol. 133, pp. 285–296, 2021.

[9] N. Van Eck and L. Waltman, "Software survey: VOSviewer, a computer program for bibliometric mapping," *Scientometrics*, vol. 84, no. 2, pp. 523–538, 2010.

[10] J. Gubbi, R. Buyya, S. Marusic, and M. Palaniswami, "Internet of Things (IoT): A vision, architectural elements, and future directions," *Futur. Gener. Comput. Syst.*, vol. 29, no. 7, pp. 1645–1660, 2013.

[11] A. Al-Fuqaha, M. Guizani, M. Mohammadi, M. Aledhari, and M. Ayyash, "Internet of things: A survey on enabling technologies, protocols, and applications," *IEEE Commun. Surv. tutorials*, vol. 17, no. 4, pp. 2347–2376, 2015.

[12] W. Shi, J. Cao, Q. Zhang, Y. Li, and L. Xu, "Edge computing: Vision and challenges," *IEEE internet things J.*, vol. 3, no. 5, pp. 637–646, 2016.

[13] Y. Mao, C. You, J. Zhang, K. Huang, and K. B. Letaief, "A survey on mobile edge computing: The communication perspective," *IEEE Commun. Surv. tutorials*, vol. 19, no. 4, pp. 2322–2358, 2017.

[14] R. N. Calheiros, R. Ranjan, A. Beloglazov, C. A. F. De Rose, and R. Buyya, "CloudSim: a toolkit for modeling and simulation of cloud computing environments and evaluation of resource provisioning algorithms," *Softw. Pract. Exp.*, vol. 41, no. 1, pp. 23–50, 2011.

[15] P. Mach and Z. Becvar, "Mobile edge computing: A survey on architecture and computation offloading," *IEEE Commun. Surv. tutorials*, vol. 19, no. 3, pp. 1628–1656, 2017.

[16] W. F. Vranken *et al.*, "The CCPN data model for NMR spectroscopy: development of a software pipeline," *Proteins Struct. Funct. Bioinforma.*, vol. 59, no. 4, pp. 687–696, 2005.

[17] Q. Zhang, L. Cheng, and R. Boutaba, "Cloud computing: state-of-the-art and research challenges," *J. internet Serv. Appl.*, vol. 1, no. 1, pp. 7–18, 2010.

[18] R. Y. Zhong, X. Xu, E. Klotz, and S. T. Newman, "Intelligent manufacturing in the context of industry 4.0: a review," *Engineering*, vol. 3, no. 5, pp. 616–630, 2017.

[19] S. Wolfert, L. Ge, C. Verdouw, and M.-J. Bogaardt, "Big data in smart farming–a review," *Agric. Syst.*, vol. 153, pp. 69–80, 2017.